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FAO Fisheries Synopsis No. 26 Revision 1
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FIb/S 26 (Rev. 1)
SAST-Anchovy - 1,21(06),002,01

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SYNOPSIS OF BIOLOGICAL DATA ON ANCHOVY

Engraulis encrasicolus (Linnaeus) 1758
(Mediterranean and adjacent seas)

Prepared by
N. Demir

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no. 26
rev. 1

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 1965

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MAST	Information on methods and subjects.
OT	Oceanographic data.
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	and
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IT	Sinopsis sobre limnología.
	y
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CB	Listes de périodiques, des sections spéciales de la « Current Bibliography for Aquatic Sciences and Fisheries », des bibliographies particulières et des articles sur les problèmes de documentation.
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Il arrive que certains documents portent d'autres numéros d'identification, comme c'est le cas s'ils ont été préparés pour une réunion dont les documents ont été marqués à l'aide d'un autre système.

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CB	Listas de periódicos, secciones especiales de la « Current Bibliography for Aquatic Sciences and Fisheries », bibliografías especiales y trabajos relativos a los problemas de documentación.
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FAO Fisheries Synopsis No. 26 Revision 1 FIb/S26 (Rev.1)
(Distribution restricted) SAST-Anchovy - 1,21(6),002,01

SYNOPSIS OF BIOLOGICAL DATA ON ANCHOVY

Engraulis encrasicolus (Linnaeus) 1758

(Mediterranean and adjacent seas)

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*As no information was available to the author, these items are not listed in the text.

1 IDENTITY

1.1 Taxonomy

1.1.1 Definition

Phylum Vertebrata
Subphylum Craniata
Superclass Gnathostomata
Series Pisces
Class Teleostomi
Subclass Actinopterygii
Order Clupeiformes
Suborder Clupeoidei
Superfamily Clupeoidae
Family Engraulidae
Genus Engraulis Cuvier 1817
Species Engraulis encrasicolus (Linnaeus) 1758

1.1.2 Description

- Engraulis Cuvier 1817

Body elongate, barely compressed; cycloid scales moderate or large, thin and deciduous; no armed abdominal keel; snout conic, projecting beyond the lower jaw; eye large, without adipose eyelid; mouth extremely large; maxillary long, slender, attached to cheek by a scarcely distensible membrane, extending back to mandible base or beyond; small teeth in jaws, on vomer, palatines and pterygoids; union of gill membranes short, leaving isthmus uncovered; branchiostegals short, varying from 9 to 14 in number; pseudobranchiae present; gill rakers long, slender, usually numerous; dorsal inserted about midway in body before anal and behind ventral origin.

- Engraulis encrasicolus (Linnaeus) 1758 (see Fig. 1)

Body rather slender; lower profile slightly convex; head quite large, compressed; snout as long as broad; interorbital broadly convex; maxillary slender, extending backward far behind eye but not quite reaching preopercle edge; row of small teeth along the whole extent of maxillary and mandible; tongue finely granular; nostrils close to each other, hind one larger; dorsal short, high; anal longer and lower than dorsal; pectoral small; four oblong scales on upper caudal lobe, three on lower.

Colour in life from greenish-blue to dark blue above, silvery white below.

Depth 7 to 7 3/5 in standard length; head 4 to 4 4/5; preventral distance 2 1/10 to 2 4/10; predorsal distance 1 9/10 to 2 1/10; preanal distance 1 4/10 to 1 5/10; eye diameter 3 to 3 7/10 in head.

D. 14 to 17; A. 16 to 20; C. n+19+n; P. 14 to 19; V. 7; gill rakers 58 to 78 = (26 to 35) + (32 to 43); Vertebrae 42 to 47 (24 to 27) + (18 to 20).

Described above from the Black, Marmara, Aegean Seas; Turkish specimens 79 to 144 mm total length.

The meristic counts given by various authors are shown in Table I.

1.2 Nomenclature

1.2.1 Valid scientific name(s)

Engraulis encrasicolus (Linnaeus) 1758

1.2.2 Synonyms

Clupea encrasicolus Linnaeus 1758
Clupea encrasicholus Lacépède 1798-1803
Clupea engraticolus Asso 1801
Clupea encrassicholus Delaroche 1809
Clupea engrasicholus Ramis 1814
Engraulis encrasicholus Cuvier 1817
Engraulis meletta Cuvier
Encrasicholus encrasicholus Fleming 1828
Engraulis vulgaris Nilsson 1832
Engraulis encrassicholus Greals 1855
Clupea encracícolus Poggi 1881

1.2.3 Standard common names, vernacular names

See Table II

1.3 General variability

1.3.1 Subspecific fragmentation (races, varieties, hybrids)

- Races

Although some statements have been made on the race composition of the Mediterranean anchovy, it is still an open question, as neither proportional measurements of body no the mean numbers of the meristic counts (see Tables III and IV) give clear evidence for the separation of geographical races or subspecies. Furthermore, the influences of the environmental factors on the mean numbers of the meristic counts have not been taken into consideration by those authors who have studied this subject up to now. Fage (1911, 1920), however, maintains that the Mediterranean anchovy is a different race from the Atlantic anchovy, differing both morphologically and biologically. Hoek (1912), quoted by De Buen (1931) states that the Naples and Zuider Zee anchovies differ in body proportions.

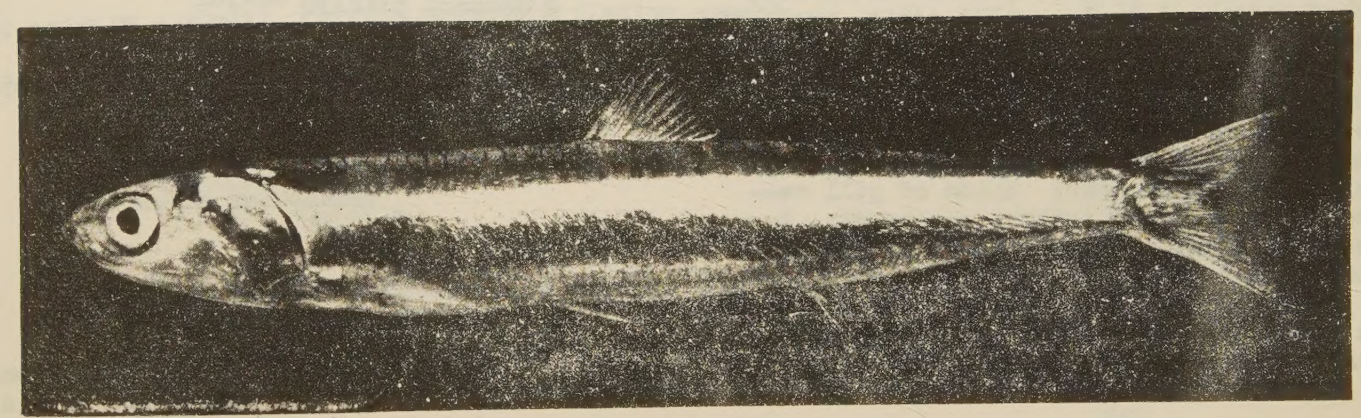

Fig. 1 - Engraulis encrasicolus from the Sea of Marmara
(Total length: 130 mm)

Table I
Meristic counts of Engraulis encrasicolus

Author	Dorsal Fin	Anal Fin	Caudal Fin	Pectoral Fin	Ventral Fin	Branchio-stegals	Gill Rakers	Vertebrae
Günther (1868)	16-17	16-17	---	---	-	12-13	---	46-47
Moreau (1881)	15-18	16-18	2/21-22/3	15-17	7	12-13	---	---
Carus (1893)	15-18	16-18	2/21-22/3	---	-	12-13	---	46-47
Kyle and Ehrenbaum (1927)	16-18	17-18	x+19+x	16-17	7	---	---	46-47
Fage (1930)	15-17	17-18	2/21	15-17	7	12-13	---	44-49
Fowler (1936)	III, 12, I	III, 14, 1	---	---	-	---	30+30	---
Lübbert and Ehrenbaum (1936)	17-18	17-18	---	17	7	---	---	44-48
Lozano Rey (1947)	3+13-15	2+13-16	---	14-17	7	---	---	---
Berg et al. (1949)	12-15	16-20	---	---	7	---	58-77	43-47
Cărăuşu (1952)	12-15	16-20	---	---	-	---	58-77	43-47(48)
Dieuzeide et al. (1954)	15-18	16-18	2/21-22/3	15-17	7	---	---	44-49
Slastenenko (1956)	12-15	17	---	---	-	---	60-77	39-47
Popiel (1962)	16-18	17-18	---	16-17	7	---	---	46-47

Table II
Common and Vernacular Names

Country	Standard Common Name	Vernacular Name(s)
Algeria	Anchouba	Ancioja, Anchois, Anchoa, Boqueron
Bulgaria	Hamsia	Sardelka
Egypt	Anchooga	
France	Anchois	Antchoyo, Anchoye, Anchoia, Anchiove, Anchiuva, Anxova, Amplova, Amplovo, Amplove-to, Amplovino, Amplona, Amploua, Amarou, Ladrot
Greece	Gávros	Kapsia, Kapsi, Khampi, Chafia, Aphyi
Israel	Afian	
Italy	Acciuga	Alice, Alici, Aléce, Aciccia, Alice'e sperone, Aliciastra, Aliciastruni, Ancioa, Anciona, Ancioja, Anciora, Anciova, Anchio, Anciva, Angioja, Anciovillo, Angiouvitta, Aggiuva, Azzuva, Amarou, Amplona, Amplova, Amplouva de fount, Bianco mangiare, Masculina, Masculinella, Masculino, Mascolini, Mezz'alici, Nini, Sardela, Sardone, Sardòn
Malta	Incova	Inciva, Inciova, Anciova, Nemusa
Monaco	Ancium	Ancina
Rumania	Hamsia	Amsi
Spain	Anchoa	Boquerón, Boquero, Bocartá, Bocarte, Bucaro, Anchova, Anxova, Aladroch, Sardinéta, Seito, Eledroc, Golfás
Tunisia	Anchouba	Anchouva
Turkey	Hamsi	
U.S.S.R.	Hamsa	Anchoye, Antschous
Yugoslavia	Brgljun	Inćun, Minćun, Inćok, Vinćun, Brgljica, Kurcilj

Table III
Vertebral frequency distribution of Engraulis encrasicolus

	Locality	Author	Number of fish having vertebral counts of:										N	M	S.D.	S.E.	Fl.M.
			39	40	41	42	43	44	45	46	47	48					
AZOV SEA		Alexandrov (1927)	1	2	4	20	86	118	33	2	-	-	266	43.57	-	-	0.063
BLACK SEA	Sevastopol	Fage (1911)	-	-	-	-	-	5	18	2	-	-	25	44.88	0.279	0.037	0.185
	St. 172	Fage (1920)	-	-	-	-	-	6	27	10	-	-	43	45.09	0.609	0.063	0.315
	Soviet waters	Alexandrov (1927)	-	-	-	-	4	55	49	8	1	-	117	44.55	-	-	-
	Eastern part	Majarova (1933) quoted by Slastenenko (1956)	-	-	-	-	-	-	-	-	-	-	-	44.49	-	-	-
	Western part	Majarova (1939) quoted by Slastenenko (1956)	-	-	-	-	-	-	-	-	-	-	-	44.45	-	-	-
	Bulgarian coast in 1952	Stoianov (1961)	-	-	-	2	15	139	422	193	5	-	776	45.03	-	-	-
	Bulgarian coast in 1954-55	Stoianov (1961)	-	-	-	-	21	315	424	32	-	-	792	44.59	-	-	-
	Fatsa Bay	Aasen and Akyüz (1956)	-	-	-	-	7	30	39	5	-	-	81	44.52	-	-	-
	Turkish coast in 1961	Demir (unpublished)	-	-	-	2	25	422	793	172	6	-	1,420	44.82	0.6976	0.0185	0.0624
SEA OF MARMARA (Gulf of Gemlik-Erdek) in 1961-62		Demir (unpublished)	-	-	-	-	6	174	795	168	9	-	1,152	45.00	0.5909	0.017	0.0573
AEGEAN SEA	Gulf of Izmir in 1961	Demir (unpublished)	-	-	-	-	2	69	320	136	5	-	532	45.13	0.6481	0.0229	0.0776
	Gulf of Thermai in 1948	Vidalis (1949)	-	-	-	-	-	-	-	-	-	-	45	44.53	0.9800	0.0940	0.4700
	Gulf of Euboea in 1948	Vidalis (1949)	-	-	-	-	-	-	-	-	-	-	360	45.31	0.6700	0.0230	0.1150
	Saronic Gulf in 1948	Vidalis (1949)	-	-	-	-	-	-	-	-	-	-	1,143	44.90	0.5605	0.0110	0.0550
IONIAN SEA	Gulf of Patras in 1948	Vidalis (1949)	-	-	-	-	-	-	-	-	-	-	24	45.83	0.5900	0.0810	0.4050
	Gulf of Catania in 1936-37	Dulzetto (1938)	-	-	-	-	-	2	106	143	49	-	300	45.79	0.7108	0.0276	0.1380
ADRIATIC SEA	Comacchio	Fage (1920)	-	-	-	-	-	9	69	29	1	-	108	45.20	0.583	0.038	0.190
	Trieste	Giudice (1922) quoted by Dulzetto (1938)	-	-	-	-	-	-	-	-	-	-	-	45.37	-	-	-
	Venice	Giudice (1922) quoted by Dulzetto (1938)	-	-	-	-	-	-	-	-	-	-	-	44.11	-	-	-
TYRRHENIAN SEA	Cannitello	Giudice (1922) quoted by Dulzetto (1938)	-	-	-	-	-	-	-	-	-	-	-	45.02	-	-	-
	Spadofora	Giudice (1922) quoted by Dulzetto (1938)	-	-	-	-	-	-	-	-	-	-	-	45.20	-	-	-
	Gulf of Naples	Giudice (1922) quoted by Dulzetto (1938)	-	-	-	-	-	-	-	-	-	-	-	45.29	-	-	-
	Ischia	Giudice (1922) quoted by Dulzetto (1938)	-	-	-	-	-	-	-	-	-	-	-	44.36	-	-	-
LIGURIAN SEA	Portofino	Giudice (1922) quoted by Dulzetto (1938)	-	-	-	-	-	-	-	-	-	-	-	45.56	-	-	-
	Cornigliano	Giudice (1922) quoted by Dulzetto (1938)	-	-	-	-	-	-	-	-	-	-	-	45.31	-	-	-
Gulf of Lion		Fage (1911)	-	-	-	-	-	1	19	28	1	1	50	45.64	0.746	0.071	0.355
SPANISH COAST	Castellón coast in 1951-55	Larrañeta (1958)	-	-	-	-	-	-	-	-	-	-	1,249	45.67	0.630	-	0.05
	Almeria	Fage (1920)	-	-	-	-	-	-	7	17	6	-	30	45.96	0.655	0.081	0.405
	Málaga	Crehuet and Val-Cordón (1960)	-	-	-	-	-	-	112	464	91	-	667	45.97	-	-	0.0715

Table IV
Dorsal fin-ray frequency distribution of Engraulis encrasicolus

	Locality	Author	Number of fish having dorsal fin-ray counts of:						N	M	S.D.	S.E.	Fl.M.
			12	13	14	15	16	17					
	AZOV SEA	Alexandrov (1927)	17	24	40	6	-	-	87	13.40	0.88	0.09	-
BLACK SEA	Sevastopol	Fage (1911)	-	7	15	1	-	-	23	13.1	-	-	-
BLACK SEA	Soviet waters	Alexandrov (1927)	2	47	78	10	-	-	137	13.70	0.63	0.05	-
BLACK SEA	Eastern part	Majarova (1939) quoted by Slastenenko (1956)	-	-	-	-	-	-	-	13.37	-	-	-
BLACK SEA	Western part	Majarova (1939) quoted by Slastenenko (1956)?	-	-	-	-	-	-	-	13.08	-	-	-
BLACK SEA	Turkish coast in 1961	Demir (unpublished)	-	-	2	59	74	5	140	15.59	0.588	0.0497	0.17
	SEA OF MARMARA (Gulf of Gemlik-Erdek in 1961)	Demir (unpublished)	-	-	2	59	127	14	202	15.76	0.586	0.0413	0.14
AEGEAN SEA	Gulf of Izmir in 1961	Demir (unpublished)	-	-	2	53	46	1	102	15.45	0.559	0.0554	0.19
AEGEAN SEA	Gulf of Thermai in 1948	Vidalis (1949)	-	-	-	-	-	-	94	15.17	0.730	0.0520	0.26
AEGEAN SEA	Gulf of Euboea in 1948	Vidalis (1949)	-	-	-	-	-	-	373	14.67	0.680	0.0230	0.115
AEGEAN SEA	Saronic Gulf in 1948	Vidalis (1949)	-	-	-	-	-	-	1799	14.52	0.650	0.0100	0.05
	IONIAN SEA (Gulf of Patras) in 1948	Vidalis (1949)	-	-	-	-	-	-	26	15.32	0.540	0.073	0.367
	Gulf of Catania in 1936-37	Dulzetto (1938)	-	2	165	133	-	-	300	14.43	0.509	0.0198	0.099
ADRIATIC SEA	Trieste	Giudice (1922) quoted by Dulzetto (1938)	-	-	-	-	-	-	-	15.24	-	-	-
ADRIATIC SEA	Venice	Giudice (1922) quoted by Dulzetto (1938)	-	-	-	-	-	-	-	15.23	-	-	-
TYRRHENIAN SEA	Cannitello	Giudice (1922) quoted by Dulzetto (1938)	-	-	-	-	-	-	-	15.27	-	-	-
TYRRHENIAN SEA	Spadofora	Giudice (1922) quoted by Dulzetto (1938)	-	-	-	-	-	-	-	15.35	-	-	-
TYRRHENIAN SEA	Gulf of Naples	Giudice (1922) quoted by Dulzetto (1938)	-	-	-	-	-	-	-	15.19	-	-	-
TYRRHENIAN SEA	Ischia	Giudice (1922) quoted by Dulzetto (1938)	-	-	-	-	-	-	-	14.11	-	-	-
LIGURIAN SEA	Portofino	Giudice (1922) quoted by Dulzetto (1938)	-	-	-	-	-	-	-	14.34	-	-	-
LIGURIAN SEA	Cornigliano	Giudice (1922) quoted by Dulzetto (1938)	-	-	-	-	-	-	-	14.32	-	-	-
	Gulf of Lion	Fage (1911)	2	30	18	-	-	-	50	13.3	-	-	-
	Balearic Islands	Fage (1911)	3	19	2	-	-	-	24	12.9	-	-	-

Fage (1920) records the existence of two groups or local races of the Mediterranean anchovy: the eastern group in the Adriatic and Black Seas with 45.13 ± 0.155 mean number of vertebrae and the western group, spreading up to Gibraltar with 45.76 ± 0.275 as the mean number of vertebrae. Alexandrov (1927) suggests that the Mediterranean, Black and Azov Seas anchovies are three different races: 1. Engraulis encrasicolus mediterraneus Fage, in the Western Mediterranean and Adriatic, 2. Engraulis encrasicolus ponticus Alexandrov in the Western Black Sea, 3. Engraulis encrasicolus maeoticus Pusanov in the Eastern parts of the Azov and Black Seas. The characteristics of these races are shown in Table V.

Majarova (1939), quoted by Slastenenko (1956) and Majarova and Chugunova (1954) distinguish two forms of Black Sea anchovy: the eastern form Engraulis encrasicolus ponticus orientalis and the western form Engraulis encrasicolus ponticus occidentalis, each having a different mean number of vertebrae, dorsal rays, gill rakers, different proportions of body, even different winter quarters, migration routes, spawning and feeding areas (see Tables III, IV and Section 3.5.1).

Dulzetto (1938) considers that the anchovy of the Gulf of Catania is different from the stocks of the Black and Adriatic Seas, Balearic Islands and Gulf of Lion even from the anchovies of the other Italian coasts. Vidalis (1949) believes that the anchovy of the Greek waters all belong to the same race.

The frequency distribution of the meristic counts given by various authors are shown in Tables III and IV.

Table V
Characteristics of the races of Engraulis encrasicolus according to Alexandrov (1927)

Race	Average length (LF) (mm)	LL x 100 / LF	LD x 100 / LF	LA x 100 / LF	Dorsal rays	Vertebrae
E. e. mediterraneus	125.0	21.72	44.00	58.15	12 - 14 13.20	44 - 48 45.44
E. e. ponticus	118.0	21.37	41.76	57.64	12 - 15 13.70	43 - 47 44.62
E. e. maeoticus	98.9	23.08	44.72	60.35	12 - 15 13.40	39 - 46 43.57

2 DISTRIBUTION

2.1 Delimitation of the total area of distribution and ecological characterization of this area

The Mediterranean and adjacent seas.

Ecological characters of this area vary greatly, especially from the point of view of temperature (annual average isotherms = 10 to 22°C) and salinity (5 to 40.0 °/oo).

2.2 Differential distribution

2.2.1 Areas occupied by eggs, larvae and other junior stages: annual variations in these patterns and seasonal variations for stages persisting over two or more seasons

2.2.2 Areas occupied by adult stages, seasonal and annual variations of these

- Eggs

Eggs are distributed all over the Sea of Azov with the exception of the areas having lowest salinity (Nikolsky, 1957); all over the Black Sea (Dekhnik, 1954; Vodianitskii and Kazanova, 1954; Einarsson and Gurtürk, 1960; Guéorghiev et al., 1961); Sea of Marmara except the parts deeper than 300 m, (Arím, 1957) and throughout all the other adjacent seas and the Mediterranean except for the central parts of the basins. Eggs become scarce along the coasts of Libya, Egypt, Israel and Southern Anatolia (Fage, 1920; De Buen, 1931).

- Larval stages

Larvae are found in all egg areas.

- Junior stages

Junior stages occur in all adult areas. Berg et al. (1949), however state that the juniors, unlike the adults, can stay in the shallow waters during the year. According to Fage (1920) these are only the juniors which are hatched in autumn.

- Adult stages

See 2.1 and 3.5.1

In the eastern central and southern Adriatic, Mužinić (1956) observed a relation between the size of the anchovy and the depth during the trawling at the end of autumn and in winter, the large fish being caught in waters deeper than 70 m. In the same period, smaller anchovies have been caught by beach seines in quite shallow coastal waters. In summer large anchovies might be found in the shallower waters too.

2.3 Behaviouristic and ecological determinants of the general limits of distribution and of the variations of these limits and of differential distribution

Since anchovy withstand 5 to 41.55°/oo salinity and 6 to 29°C temperature ranges, there is no limiting factor for the general distribution in the Mediterranean and adjacent seas from the point of view of temperature and salinity. But the eggs and larvae are not found in waters which have a temperature lower than 13°C (the most favourable temperature range being 20 to 25°C; salinity 9 to 37.5°/oo).

In spring, the occurrence of the adults in the surface layers of coastal waters depend mainly on the surface temperature of the water and the abundance of plankton as food. In autumn, the migration to the deeper layers also depends mainly on the temperature. In the Mediterranean, the temperature which stimulates the fish to move to deeper and warmer layers is about 12°C (Fage, 1911).

3 BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.1.1 Sexuality (hermaphroditism, heterosexuality, intersexuality)

Heterosexual without external secondary characters. The case of hermaphroditism has been observed by Mužinić (1956) in one specimen from the Adriatic.

3.1.2 Maturity (age and size)

Anchovy reach maturity at the end of their first year of life. Fage (1920) states that the individual hatched in autumn matures in the eleventh month.

Authors disagree on the length when sexual maturity first occurs. Fage (1920) and Cărăuşu (1952) report that it is 12 to 13 cm. Along the coast of Castellón (Western Mediterranean) the minimum length of mature fish is 111 mm for males, 117 mm for females (Andreu and Rodríguez-Roda, 1951a); on the coast of Blanes, 118 mm for males, 119 mm for females (Bas and Morales, 1954) in the Adriatic, 111 mm for males, 114 mm for females (Mužinić, 1956). Vidalis (1949) says that the minimum length is about 100 mm for anchovy from Greek waters and individuals 80 to 95 mm are probably mature.

3.1.3 Mating (monogamous, polygamous, promiscuous)

The anchovy is polygamous.

3.1.4 Fertilization (internal, external)

External and takes place immediately upon spawning.

3.1.5 Fecundity

- Relation of gonad size and egg number to body size and to age

The relation between the sizes of the gonad and the body of the anchovy off Blanes (Western Mediterranean) given by Bas and Morales (1954) is shown in Table VI.

Slastenenko (1956) says that a female can produce as many as 40,000 eggs. Nikolsky (1957) states that the average number of eggs is 13,360. Detailed investigations on the fecundity of different sizes have, however, been made by Majorova and Chugunova (1954). See Table VII.

- Coefficient of fecundity

The indices of fecundity of the Spanish anchovy from the coast of Blanes shown in Table VIII, are those given by Bas and Morales (1954).

3.1.6 Spawning

- Spawning seasons (beginning, end, peak)

The data in Table IX show that on the whole, the spawning of anchovy does not take place before April or after November, mostly not after October, while the peak falls in the summer months.

- Number of spawnings per year, frequency

Anchovy have only one spawning season per year. But the ovarial eggs of the individual fish do not mature at the same time and are not spawned all at once. By studying the size of the ovarial eggs of the Black Sea anchovy and classifying the ovaries according to a scale of maturity, Majorova and Chugunova (1954) found evidence of three different egg groups at differing degrees of maturity. They consider the first group to have been shed in June-July, the second in July-August and the third in September.

- Spawning time of day

Soviet authors are unanimous that the Black Sea anchovy spawns between midnight and 4 a.m., but, according to Vučetić (1957), it occurs between approximately 19.00 and 21.00 hrs in the Lakes of Mljet Island (Adriatic).

- Induction of spawning, artificial fertilization

The minimum temperature for the ripening of gonads is about 13°C (Fage, 1920). Eggs

Table VI
Relation of gonad size to body size (Bas and Morales, 1954)

Body length (mm)	Gonad weight				Gonad length			
	Male		Female		Male		Female	
	f	M	f	M	f	M	f	M
120	12	0.34	3	0.29	12	28.5	3	27.6
130	16	0.36	20	0.59	12	28.1	18	35.8
140	20	0.53	3	0.88	15	38.2	3	37.3
150	17	0.55	1	0.67	15	34.4	-	---
160	3	0.73	-	---	3	39.3	-	---

Table VII

Number of eggs (x 1000) produced by the Black Sea anchovy (Majarova and Chugunova, 1954)

Group	First			Second			Third			Fourth		
Number of eggs in ovarium	3 Portion			2+ Portion			2 Portion			1 Portion		
Phase of maturity	IV, V			V-VI			VI-III and VI - IV			VI-III (III)		
Length of fish in cm	M	Range	n	M	Range	n	M	Range	n	M	Range	n
7-8	13.7	11.7-15.8	2	-	-	-	-	-	-	-	-	-
8-9	17.5	14.0-21.1	2	13.6	10.8-16.9	3	-	-	-	-	-	-
9-10	18.6	18.6	1	15.9	14.4-16.7	5	-	-	-	-	-	-
10-11	20.0	20.0	1	16.3	16.3	1	19.2	19.2	1	-	-	-
11-12	26.3	21.6-30.9	5	-	-	-	16.6	12.7-19.9	7	9.4	8.2-10.8	3
12-13	27.6	24.4-31.4	7	27.2	27.2	1	16.8	11.8-22.5	10	-	-	-
13-14	29.6	29.6	1	-	-	-	18.3	18.3	1	6.9	6.9	1

Table VIII
Indices of fecundity (Bas and Morales, 1954)

Length of fish in mm	Index of fecundity	
	Frequency	Mean
120	16	2.47
130	36	3.08
140	27	3.06
160	3	2.87

Table IX
Spawning seasons

Locality		Author	Spawning season		
			Beginning	Peak	End
AZOV SEA		Berg et al. (1949)	June	-	August
		Slastenenko (1956)?	May	-	August
		Nikolsky (1957)	end of May	-	second half of August
BLACK SEA	Soviet waters	Dekhnik (1954)	end of April or May	-	September October
		Vodianitskii and Kazanova (1954)	May	-	September
		Slastenenko (1956)	end of May	-	end of September
	Bulgarian waters	Gueorghiev et al. (1961)	end of May	second half of June-second half of August	end of September
SEA OF MARMARA		Arim (1957)	second half of April	July	second half of October
Greek waters		Vidalis (1949)	May	-	November
ADRIATIC SEA	Split	Gamulin (1940)quoted by Vučetić (1957)	second half of April	-	end of August
	Lakes of Mljet Islands	Vučetić (1957)	May	-	September
	Upper Adriatic	Karlovec (1963)	May	July-September	October
	Chioggia Canal	Varagnolo (1964)	second half of April	June	end of October
ITALIAN WATERS	Gulf of Catania	Russo (1925) quoted by de Buen (1931)	April	August	September
	Gulf of Naples	Raffaele (1888)	May	-	September
		Lo Bianco quoted by D'Ancona (1933)?	April	-	September
SPANISH MEDITERRANEAN	-	Lozano Rey (1947)	April	-	September
	Castellón coast	Planas and Vives (1951)	-	June-July	September October
	Málaga	Miranda-Rivera (1930, 1931) quoted by Andreu and Rodríguez-Roda (1951b)	May, June	July-August	August, September
Algerian waters		Dieuzeide et al.	April	-	Second half of September
MEDITERRANEAN AREA		Fage (1920)	April	June-July	September

have never been found below this temperature and if the temperature of the surface waters is high enough, anchovy tend to spawn throughout the year. This is why the spawning season is longer in southern areas than in northern ones. It can be concluded that temperature is the main factor in inducing spawning.

3.1.7 Spawning grounds

- Coastal (surface, vegetation, shore, shoal, sand, shelter); bottom
- Oceanic (surface, bottom)

Although the main concentration of eggs is in coastal waters, they are also found in oceanic waters.

The eggs float between the surface and a depth of 50 m. Dekhnik (1954) states that the main concentrations of eggs are found at 5 to 10 m depth, the number decreasing gradually down to 25 m. Below 25 m eggs are few and show signs of abnormal development.

3.1.8 Egg: structure, size, hatching type, parasites and predators

- Structure

Anchovy eggs are pelagic and differ from the eggs of most pelagic fish in that they are ovoid rather than spherical. In the living eggs, the capsule is thin and elastic, the perivitelline space narrow, the yolk mass segmented, colourless translucent, without oil globules.

Blastoderm forms at the lower pole of the egg and the embryo develops along the long axis and has no pigment (see Fig. 2). During development, the eggs float with the long axis perpendicular to the surface of the water.

- Size

The sizes of the eggs collected from various seas are shown in Table X. By measuring the diameters of the longitudinal and transverse axes of eggs from the Turkish waters of the Black, Marmara, Aegean and Mediterranean (Gulf of Iskenderun) Seas and calculating the mean axial lengths, axial ratios, volumes of these eggs according to each sea, Demir (1959) found marked variations in egg size and shape. Fig. 3 shows that egg size or volume increases gradually and the shape becomes more spherical from the Mediterranean to the Black Sea.

- Parasites and predators

All plankton-feeders prey on the eggs.

3.2 Larval history

3.2.1 Account of embryonic and juvenile life (prelarva, larva, postlarva, juvenile)

- Prelarva

The newly hatched prelarva is elongated in shape and has a long oval yolk sac. There is no mouth or pharyngeal cavity. Intestine is slender and straight. Anus is situated at the margin of embryonic fin, well to the back. Notochord is large and multicolumnar, at least partly. Pectoral fins appear as small semicircular folds on either side of the subnotochordal region and rather remote from head. There are several black chromatophores or melanophores on the ventral side of the body. The prelarval characteristics are shown in Fig. 4 which belong to a somewhat advanced phase.

- Larva, postlarva

The anchovy larva and postlarva can easily be distinguished from the Clupeidae larva and postlarva because the anchovy's dorsal and anal fins are differently placed. The front of the anchovy's anal fin is ahead of the rear of the dorsal. That is, the anal would seem to overlap the dorsal, if seen from the side of the fish. In the Clupeidae, a side view would show a clear separation between the anal and dorsal fins.

In the anchovy, the tail is longer than the head; in the Clupeidae, the tail is equal in length or shorter than the head. A final difference is that anchovy larvae and postlarvae generally have fewer miotomes than Clupeidae larvae and postlarvae. Fig. 5 shows the larvae and postlarvae of the Marmara anchovy corresponding to definite development stages.

- Juvenile

The principal characteristics of the

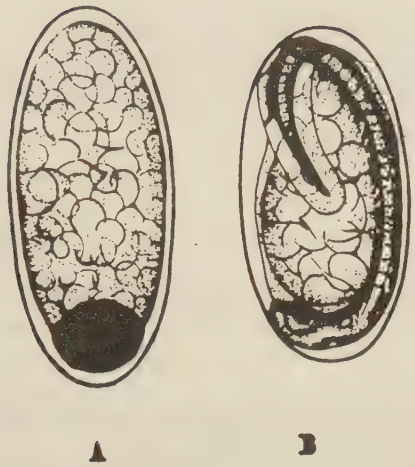

Figure 2. Eggs of Engraulis encrasicolus from the Sea of Marmara (preserved material), A=0.60 x 1.35 mm, B=0.65 x 1.25 mm

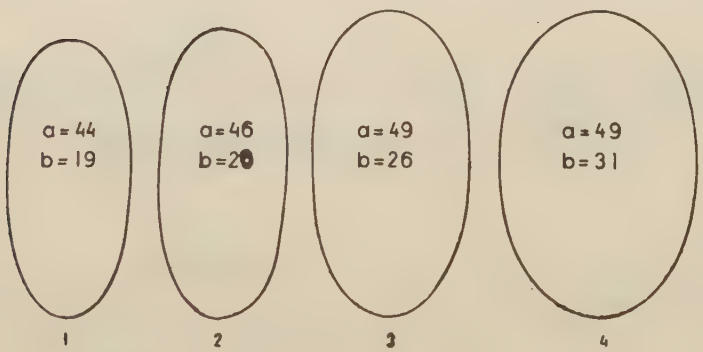

Figure 3. Comparison of the eggs in mean size and shape originating from the Mediterranean (1), Aegean (2), Marmara (3), and Black (4) Seas. a= Longitudinal axis, b= transversal axis, the measurements are shown by unities (38 unities = 1 mm) (Demir, 1959)

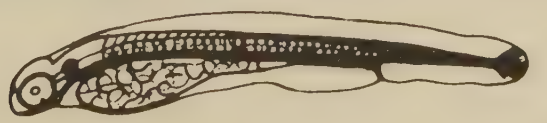

Figure 4. Prelarva (2.9 mm) of Engraulis encrasicolus from the Sea of Marmara (preserved material)

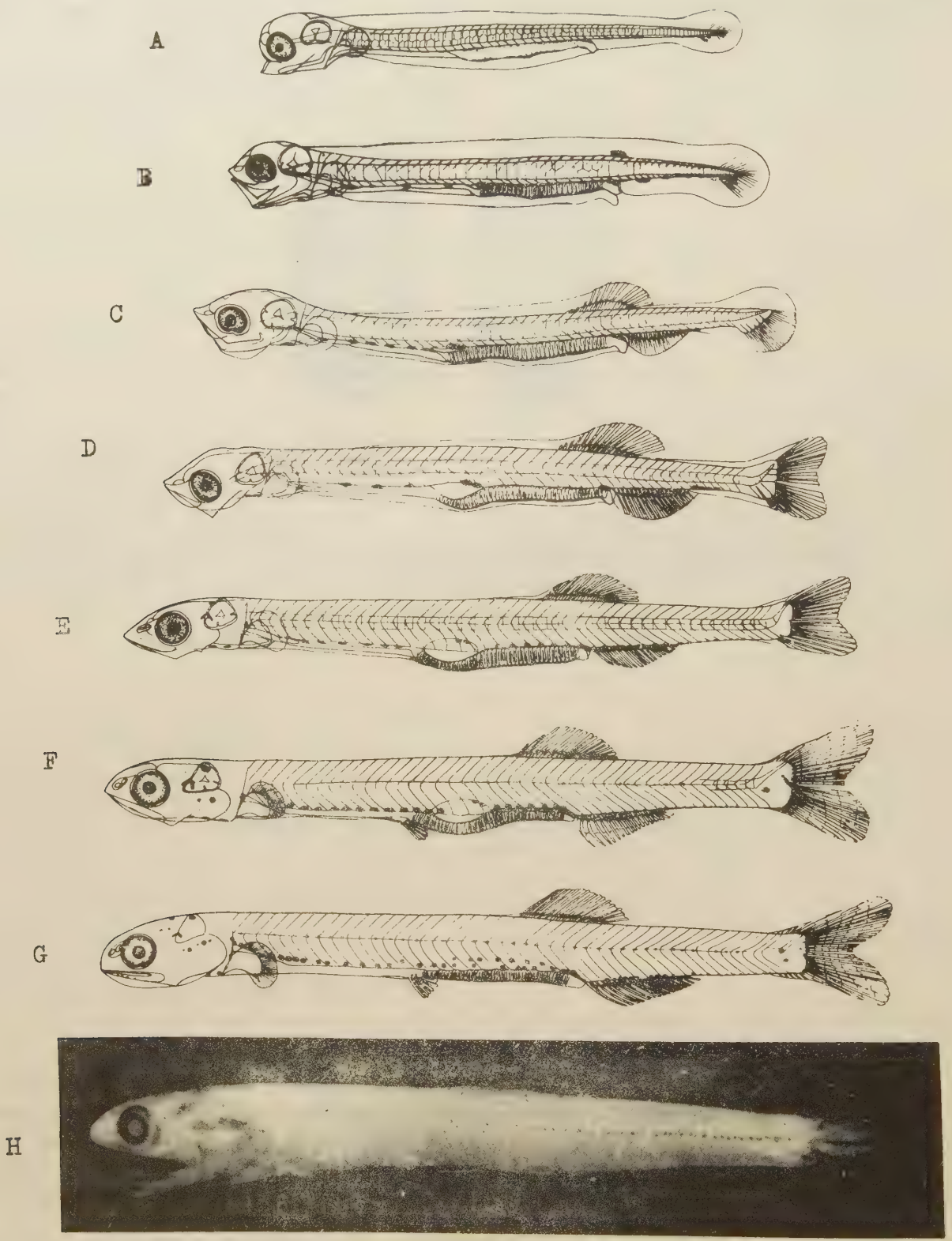

Figure 5. Larvae and postlarvae (A = 3.3 mm, B = 6 mm, C = 9 mm, D = 12 mm, E = 18 mm, F = 24 mm, G = 27 mm, H = 31.5 mm metamorphosed specimen) of Engraulis encrasicolus from the Sea of Marmara (preserved material)

Table X
Egg size of Engraulis encrasicolus

Locality		Author	Transversal axis in mm	Longitudinal axis in mm
BLACK SEA	Soviet waters	Berg et al. (1949)	1.2	1.9
		Vodianitskii and Kazanova (1954)	0.8-1.2	1.5-1.9
	Turkish waters	Demir (1959)	0.66-0.95	1.05-1.58
SEA OF MARMARA		Demir (1959)	0.60-0.84	1.03-1.63
AEGEAN SEA (Turkish waters)		Demir (1959)	0.42-0.63	0.90-1.50
MEDITERRANEAN	Gulf of Naples	Raffaele (1888)	0.50-0.55	1.15-1.25
	Castellón waters	Andreu and Rodríguez-Roda (1951 b)	0.51-0.61	1.22-1.50
	Gulf of Iskenderun	Demir (1959)	0.47-0.55	1.05-1.29

juvenile, differentiating it from the adult, are the proportions of the body and the presence of silvery lateral bands on each side of the body.

- Feeding

Pre-larvae feed on yolk sac. Pavlovskaia (1955, 1961), states that prelarvae, when the mouth is formed, also consume some Peridiniae and other phytoplankton organisms of a diameter of 40 to 50 μ.

The other larval stages feed on phytoplankton and zooplankton organisms. According to Kornilova (1955) the larva consumes both phytoplankton and zooplankton organisms from the time of absorption of yolk mass to a length of 5 to 6 mm. When this length is reached, zooplankton is the main food of the successive larval stages. According to Pavlovskaia (1955, 1961) when the absorption of the yolk mass is completed, larvae and juveniles separate into four length groups, each having different digestive systems and feeding habits. The larvae of the first group are about 4 to 10 mm long and 70 to 80 percent of their food is nauplii copepods. The length of the second group ranges from 10 to 25 mm; their main foods are copepods in the stages of nauplii and copepodite I. The principal food of the third group, in which the larvae are 25 to 30 mm long, is copepodite in stages I-IV, adult copepods and cladoceras. In the fourth group, juveniles are 35 to 50 mm long and they feed mainly on copepods and cladoceras.

In the opinion of Nikitin (1948) quoted by Nikolsky (1957) cirripedia larvae have great importance in the feeding of Black Sea anchovy juveniles.

- Rates of development and survival

- Rates of development

See Table XI and XII and Fig. 6.

- Rates of survival

Pavlovskaia (1955) reports that the survival rates of the eggs of the Black Sea anchovy which are produced by a female are 25 to 35 percent and the survival rates of the larvae and juveniles depend especially on the quality and quantity of plankton available as food.

Kornilova (1955) recorded a survival rate between 0.1 and 9.6 percent for the number of living eggs found in one cubic meter samples of water from the Azov Sea (0 to 1 m depths) during the 1950-53 spawning seasons.

- Periods of: development and survival

From about April or May to about November or December.

- Parental care

There is no parental care.

- Parasites and predators

There is no available information on the parasites of larvae and juveniles.

The predators of larvae are all animals feeding on plankton. The predators of juveniles are large and small fish, including the anchovy itself.

3.3 Adult history

3.3.1 Longevity

Fage (1911, 1920) states that the oldest Mediterranean anchovy is two years old. Majarova and Chugunova (1954) and Stoianov (1961) record four-year-old anchovy in the Black Sea.

3.3.2 Hardiness

The anchovy can stand a temperature between 6 and 29°C and can accomodate itself easily to changes in salinity between 5 and 41.55 °/oo when the rise of both is gradual. Although its natural food is plankton organisms, it can also swallow fish.

3.3.3 Competitors

The main competitors are Sardina pilchardus, Sardinella aurita, Clupea sprattus, Trachurus trachurus, T. mediterraneus, Scomber scombrus.

3.3.4 Predators

Sea birds, Delphinus delphis, Tursiops

Table XI
Rates of development of Engraulis encrasicolus

Author	Incubation		End of absorption of yolk mass	
	Temperature °C	Duration	Temperature °C	Duration
Raffaele (1888)	-	2 - 3 days	-	4 - 5 days
Berg et al. (1949), Cărăuşu (1952)	-	25-30 hours	-	-
Kornilova (1955)	22-24	38-39 hours	22-24	4 days
Vodianitskii and Kazanova (1954)	-	24 hours	-	-
Pavlovskaia (1955)	-	-	25	30 hours
			12	120 hours
Nikolsky (1957)	15	65 hours	-	-
	25-27	29 hours		
Vučetić (1957)	22	40 hours	-	-
	27	24 hours		

Table XII
Rates of development of Engraulis encrasicolus

Locality	Author	Length of larva in mm					
		Hatching	End of absorbtion of yolk mass	D. rays become conspicuous	A. rays become conspicuous	Appearance of V.	Formation of scales
AZOV SEA	Kornilova (1955)	1.7	3.6-4.0	-	-	-	27.0
BLACK SEA	Berg et al. (1949)	2.0	-	-	-	-	25.0
	Vodianitskii and Kazanova (1954)	1.58-1.60	3.0	-	-	-	-
	Pavlovskaia (1955)	1.75-1.80	4.0	6.0-7.0	6.0-7.0	-	-
SEA OF MARMARA	Demir (unpublished)	2.5-2.7	3.5-4.0	5.2-5.9	5.5-6.2	14.5-15.0	31.0-35.0
MEDITERRANEAN SEA	Fage (1920)	3.3	4.0-5.0	-	-	15.0	35.0-40.0

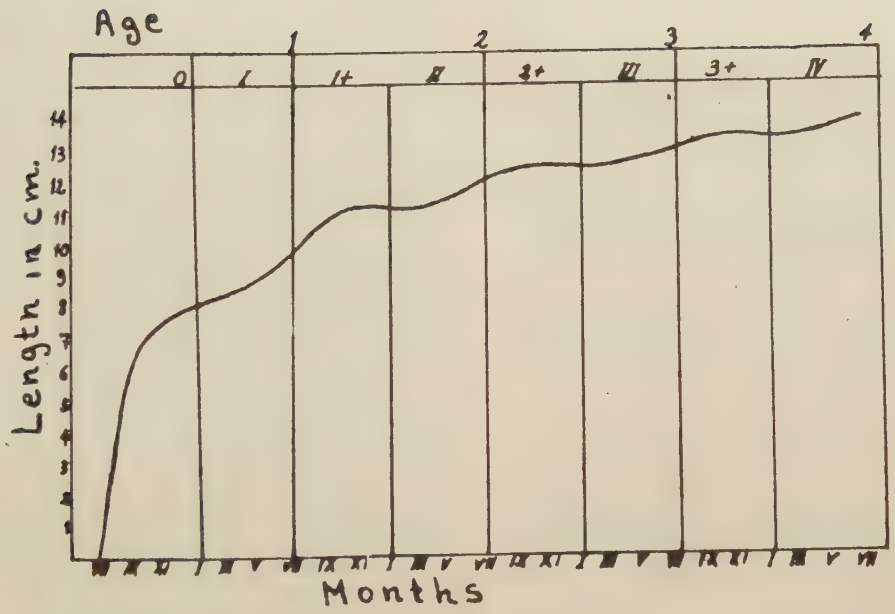

Figure 6. Average growth of the Black Sea anchovy caught during 1956-1960 off Bulgarian coasts (Stoianov, 1961)

tursio and all predacious fishes, especially Huso huso, Thunnus thynnus, Auxis thazard, Sarda sarda, Scomber scombrus, Belone belone, Lucioperca lucioperca, Caspialosa pontica.

3.3.5 Parasites and diseases

In the Black Sea, nematode larva is the well-known endoparasite of the anchovy. According to Margaritov (1960), it is larva of Contracaecum sp.

Reichenbach-Klinke (1958) gives the following list of parasites of anchovy and reports that he found them (except the first) in the digestive systems and internal organs of Naples anchovies.

TREMATODES:	Aponurus lagunculus Loss Aphanurus stossichi (Monticelli) Metacercaria (Bucephalides?)
CESTODES:	Scolex pleuronectis Müller (Plerocercoid of one Tetraphyllidae)
NEMATODES:	Contracaecum clavatum (Rud.)
FUNGI:	Ichthyosporidium hoferi (Plehn and Mulsow)

According to Reichenbach-Klinke (1958), the last named parasite, which infests 15 percent of the fishes, causes a grave disease which kills the fish within a short time.

Although Lernaenicus encrasicola (Turton) is an ectoparasite of both anchovy and sprat (Clupea sprattus L.), there is no report that this parasite has been observed in the Mediterranean anchovy.

3.3.6 Greatest size

Mužinić (1956) has reported that two anchovies belonging to the total length class 180-189 mm have been found in the Adriatic.

3.4 Nutrition and growth

3.4.1 Feeding (time, place, manner, season)

Since anchovy look for their food actively, (observations in aquarium by Mužinić, 1960) feeding takes place during the daytime. According to Dimov (1961) anchovy usually feed twice during the nyctemeral cycle: in morning and evening. But a complementary feeding can occur in the middle of the day.

Feeding is much more intensive during summer than in winter. Nikolsky (1957) states that the Azov Sea anchovy, after intensive summer feeding, generally interrupt feeding. When they migrate to the Black Sea in autumn, they consume little food there until winter is half over; from mid-winter until spring, the anchovy do not consume any food.

3.4.2 Food (type, volume)

According to Fage (1911), when anchovy are in surface layers, they feed on plankton organisms, preferably copepods, mysids and the embryos of coastal crustacean species. When they are isolated in deep waters, several diatoms and some small benthic animals in a certain quantity of clay or the fragments of annelids, Pagurus, and small fishes have been found among their stomach contents.

Okul (1940) quoted by Slastenenko (1956) reports this food composition in the Azov Sea: copepods 60.2 percent; phytoplankton 10.9 percent; adults and larvae of polychaets 9.5 percent; cirriped larvae 5.8 percent; fish larvae 5.1 percent and mollusc larvae. Nikolsky (1957) states that the food of the Azov Sea anchovy generally consists of copepods 60 percent; polychaets 20 percent; and cirripeds 20 percent. In the feeding of the Black Sea anchovy copepods with 35 to 55 percent, occupied the first place; decapod larvae 18 to 35 percent, the second; and mollusc larvae the third. According to Chajanova (1954), Copepoda, Cladocera, larvae of Cirripeda, Decapoda, Mysidae and Sagitta, Oikopleura, Mollusca larvae constitute the main food of the Black Sea anchovy. Polychaet and fish larvae are rarely found among stomach contents. The quantity of these organisms varies with the month and locality, copepods always occupy first place in the Black Sea anchovy's diet.

Dieuzeide et al. (1954), on the other hand, say that although anchovy feed on plankton organisms, they also prey on rather large fishes.

According to Verheijen (1960), data on the stomach content of the anchovy indicate that they are sometimes cannibalistic.

3.4.3 Relative and absolute growth patterns and rates

See Table XIII.

3.5 Behaviour

3.5.1 Migration and local movements

The main features of the migration of anchovy are as follows: in March and especially from April-May to June, anchovy occur in the superficial layers. During summer they approach shallower waters, even penetrating into lakes, lagoons and estuaries. In autumn, from September to January, they pass into deeper and warmer waters which are 100-150 m in depth and of a temperature of 13°C in the Mediterranean (Fage, 1911), and 70-150 m in depth and at 8°C in the Black Sea. (Nikolsky, 1957, 1963)

Majarova and Chugunova (1954), who distinguish the eastern and western forms of Black Sea anchovy, give details of these movements in that sea. In the eastern Black Sea, the anchovy has its main winter quarters off the Caucasian coast. During spring, it migrates northwards and spreads throughout the eastern oceanic water. The western form, which winters off the Crimean peninsula, migrates mainly to the northwestern area, but also spreads all over the western Black Sea during spring. At the beginning of winter, both forms seek coastal waters. From November to January they are near the surface, but descend to 70 to 80 m later in the winter. Between March and April, the eastern form begins the spring migration. In the northwestern Black Sea, the spring migration begins in May, with maximum intensity in June. During summer, both forms are found above the thermocline all over the Black Sea. The main features of the winter quarters and migration routes given by the above authors are shown in Fig. 7. The winter quarters are characterized by special depth conditions, viz. shallow water (20 to 30 m) bordered by oceanic depths which cut into the continental terrace as gorges or submarine valleys. The current is slow in the gorges and there the anchovy aggregate. The schools vary in size and move constantly; during the day, they are at 45 to 55 m, but at night spread out and come up to 20 to 25 m.

A great number of anchovy seek winter quarters in the Turkish waters of the Black Sea. Aasen and Akyüz (1956) recorded winter schools in Fatsa Bay in the eastern Black Sea. But some anchovy migrate to the Sea of Marmara during autumn. The spring migration toward the Black Sea generally begins at the end of April.

Soviet authors, on the other hand, say seasonal migrations take place between the Azov and Black Seas. Popova (1954) states that the autumn migration of the Azov Sea anchovy toward the Black Sea and its winter quarters off the Crimean peninsula and Caucasus coast, begins in September or October. The return migration takes place in April and May. The winter quarters and migration routes of this anchovy are shown in Fig. 8.

According to Nikolsky (1963), the movement of the anchovy away from the surface waters into greater depths by day and from the deeper water to the surface by night has been observed in the Black Sea. According to the above mentioned author, these movements usually have a protective significance as when the fish is found in the great depths, it is relatively unavailable to fish-eating birds.

3.5.2 Schooling

Anchovy display a schooling instinct in all phases of life.

3.5.3 Reproductive habits

See 3.1.1, 3.1.3, 3.1.4, 3.1.6, 3.1.7.

Table XIII
Relation between age and length

Locality		Author		Length in mm							
				0	1	1+	2	2+	3	3+	4
AZOV SEA		Berg et al. (1949)		41-77 55	71-107 87	-	97	-	-	-	-
		Nikolsky (1957)		-	84	-	94	-	103	-	-
BLACK SEA	Soviet waters	Berg et al. (1949)		44-80 66	83-137 111	-	119	-	-	-	-
	Eastern part (Batumi, Sukhumi)	Majarova and Chugunova (1954)		63-79	-	92-111	-	105-118	-	119-121	-
	Western part (Yalta)	Majarova and Chugunova (1954)		74-84	81	109-122	114	121-128	124	128-131	129
	Rumanian waters	Cărăuşu (1952)		-	120-130	-	140	-	-	-	-
	Bulgarian waters	Stoianov (1961)		80	99	110	118	123	128	-	138
Greek waters		Vidalis (1949)		-	90-110	130-140	-	-	-	-	-
Upper Adriatic		Padoan (1963)	*in 1960-1961	55.00 -	110.93 112.61	- -	121.12 121.39	- -	130.99 130.82	- -	- -
Spanish Mediterranean, Roussillon coast		Fage (1911, 1920)		-	120-130	-	150-170	-	-	-	-

*as standard length

Figure 7. Seasonal distribution and migration routes of the Black Sea anchovy (Majarova and Chugunova, 1954)

Figure 8. Seasonal distribution and migration routes of the Azov Sea anchovy (Majarova and Chugunova, 1954)

4 POPULATION (STOCK)

4.1 Structure

4.1.1 Sex ratio

According to Andreu and Rodríguez-Roda (1951b) the sex ratio of Catalan anchovy by percentage is:

	July	August	November
Males	63.8	20.8	31.3
Females	36.2	79.2	68.7

According to Crehuet and Val Cordón (1960) the sex ratio was 38.10 percent males, 61.90 percent females in 1,079 anchovies from Malaga. Mužinić (1956) recorded 124 or 52.3 percent males, 112 or 47.3 percent females and one hermaphrodite in 237 specimens from the Adriatic collected between the end of November 1954 and the middle of March 1955. Porumb and Porumb (1958) give the following sex ratios of the anchovy caught in 1954 in Rumanian littoral waters, by percentage.

	May	June	July	September	October
Males	41.86	10.97	38.46	38.09	58.33
Females	58.13	89.02	61.90	61.90	41.66

In 1,042 anchovies collected from the upper Adriatic in 1960-61, Padoan (1963) found that 478 were males and 564 were females, the sex ratio varying both from month to month and from year to year.

In samples of anchovy from the commercial catches in the Gulf of Naples from February to May 1962, the females predominated over the males and there was a significant different from the 1:1 sex ratio. (Dragesund, 1964)

4.1.2 Age composition

Observations on age composition of anchovy stocks are relatively few. According to Fage (1911), Mediterranean anchovy populations are composed of fishes one and two years old. According to Slastenenko (1956), the age composition of the Azov Sea anchovy in commercial catches, formed the following classes:

Year class	0	1	2	3
Percentage	33-88	7.58	5	0.2-0.3

Majarova and Chugunov (1954) and Stoianov (1961) give the following age composition of the Black Sea anchovy stock (by percentage) according to the averages of 1949-52 and 1952-59 respectively.

Age	1+	2+	3+	4+
Majarova and Chugunova (1954)	72.9	16.9	9.9	0.3
Stoianov (1961)	53.14 to 66.27	29.03 to 32.58	4.67 to 13.48	0.03 to 0.80

According to Padoan (1963), the age composition of 1,042 anchovy caught in the upper Adriatic during 1960-61 is as follows:

Year class	0	1	2	3
Percentage	2.97	62.67	31.58	2.78

Dragesund (1964) records that samples obtained from the commercial landings in the Gulf of Naples from January 1961 to July 1962 probably consist almost entirely of one year class (1961 year class).

4.1.3 Size composition

According to Slastenenko (1956), the length and weight of the Azov Sea anchovy in commercial catches, vary between 80 and 110 mm, 6 and 12 g respectively. In the Black Sea the length composition of the anchovy catch ranges from 55 to 170 mm (Borcea, 1932; Majarova and Chugunova, 1954; Stoianov, 1961); in the Aegean Sea, from 50 to 150 mm (Vidalis, 1949; Demir, unpublished data). The length of the Israel coast anchovy is between 52 and 110 mm (Ben-Tuvia, 1953). Mužinić (1956) gives the length distribution of 237 anchovy caught along the Dalmatian coast as ranging between 80 and 180 mm with modes 110 and 160 mm. (lower class limits have been used) According to Hoek (1912) quoted by Fage (1920), the length of the Naples anchovy varies from 110 to 159 mm with a mode of 120 to 129 mm. Dulzetto (1938) gives the length distribution of 300 anchovy caught in the Gulf of Catania as ranging from 90 to 149 mm with a

mode of 115 to 119 mm. Andreu and Rodríguez-Roda (1951a) give the following length-frequency distribution of 1,867 anchovy caught in 1949-50 off the coast of Castellón:

Length (in mm)	60	70	80	90	100	110	120	130	140	150	160	170
Percentage	0.2	2.9	1.7	0.4	0.4	5.4	13.7	23.3	27.8	20.0	3.8	0.2

Crehuet and Val Cordón (1960) give the length and weight distribution of 1,079 anchovy from Malaga. These fishes range from 95 to 154 mm with a mode of 120 to 124 mm and from 8.3 to 32.3 g respectively.

Dragesund (1964) gives the length distributions and the average lengths of 1,664 anchovy obtained from the commercial catches in the Gulf of Naples from November 1961 to August-September (1962), (see Fig. 9).

4.4 Mortality, morbidity

4.4.1 Rates of mortality

According to Popova (1954), the rates of mortality of the stock of the Azov Sea anchovy vary between 40 and 80 percent, averaging 60 percent in the Black Sea where they are found spending the winter months. Mortality rates of the Black Sea anchovy off the Bulgarian coast are shown in Fig. 10.

4.6 Relation of population to community and ecosystem, biological production, etc.

Anchovy depend especially on the pelagic community. Pavlovskaia (1961) showed that in the northwestern Black Sea, a definite relation existed between the abundance of anchovy juveniles and the quantity of the zooplankton available as food.

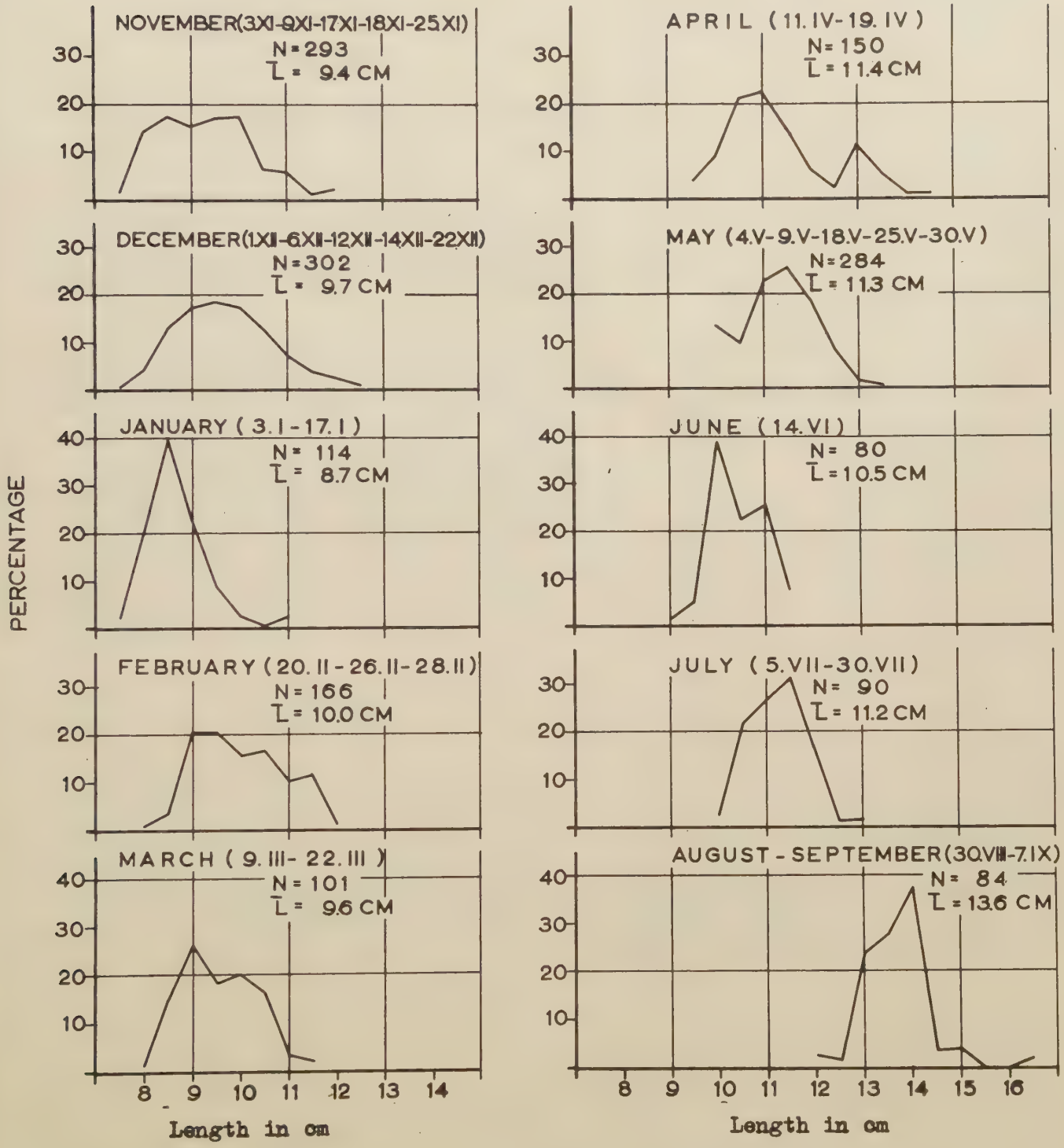

Figure 9. Length distribution of anchovies, November 1961 to August-September 1962 (Dragesund, 1964)

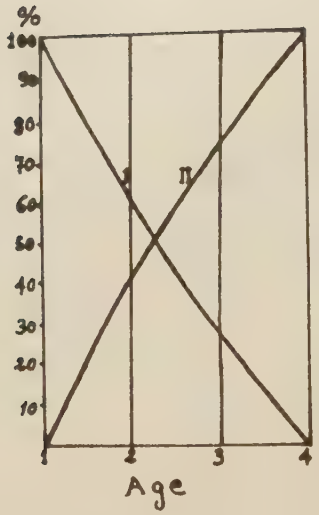

Figure 10. Curve of mortality of the Black Sea anchovy in Bulgarian waters, I - Survival, II - Mortality (Stoianov, 1961)

5 EXPLOITATION

5.1 Fishing equipment

5.1.1 Fishing gear

The most important gear are: purse seines, beach seines, lampara, ring nets, trap nets, gill-nets.

According to Akyüz (1959), the midwater trawl (Danish vinge-trawl) is also an important modern implement for anchovy fishing. Large quantities of anchovy can be caught by this trawl in winter.

In anchovy fisheries, artificial lights are also used extensively in many countries, light being a part of the fishing equipment. The light source varies from the light burning pine branches on a grill, to petroleum, acetylene and petroleum gas lamps and electric lamps. The predominance of one of these light sources varies from country to country. For instance, petroleum gas lamps are predominant in Yugoslavia (Mužinić 1960b) and Spain (Andreu and Rodriguez-Roda, 1951a), while some Italian purse seine fishermen have recently replaced the gas pressure lamps with underwater electric lamps (Kristjonsson, 1959).

For the detection of the fish, echo-sounders are successfully used.

In the open central and North Adriatic, Vučetić (1964), has recorded that during the fishing season besides the fish echo-traces, the data on the number as well as the stage of development of the eggs in the plankton may be used for locating the areas of greater concentration of the adult anchovy.

5.1.2 Fishing boats

No special boat types are used for anchovy.

5.2 Fishing areas

5.2.1 General geographic distribution

Anchovy fisheries are located everywhere the fish is known. The important fishing areas are: the Black, Marmara, Aegean, Adriatic Seas, the south coast of Sicily (Sea of Lampedusa), the Gulf of Genoa, the western coast of the Gulf of Lion, the coast of Cataluña, Málaga and the Nemurs region of Algeria.

5.2.2 Geographical ranges (latitudes, distances from coast, etc.)

From 5 to 10 m to 15 to 20 nautical miles offshore.

5.2.3 Depth ranges

From 5 to 100 m.

5.3 Fishing seasons

5.3.3 Dates of beginning, peak and end of season

The fishing season generally lasts all the year round, with peaks either in autumn and spring, when migration takes place, or in winter, when the fish have moved to winter quarters. See Table XIV

5.3.5 Factors affecting fishing season

Migration depends on both the physiological state of the fish, and on environmental changes, especially temperature. Thus, according to Shuleman (1959) quoted by Nikolsky (1963), anchovy containing 14 percent fat do not migrate in winter however far the temperature falls. With a fat content of 14-17 percent, a drop in temperature of 9-14°C is necessary for the start of the winter migration. With a fat content of 22 percent, the anchovy start to migrate with any drop in temperature.

As water temperature seems responsible for migrations, and season peaks generally coincide with either migration times, or times when fish are in winter quarters, water temperature seems a valuable indicator of availability. For instance, in the Black Sea, the optimum temperature ranges of the fishing season are between 7 and 19°C. At temperatures higher than 21 or 22°C, anchovy fishing

Table XIV
Fishing seasons

Country	Fishing season
ALGERIA	Especially in winter months
BULGARIA	All the year round with peaks in spring and autumn
FRANCE	
Gulf of Lion	All the year, with peaks in spring and autumn
ITALY	Especially from March to September
RUMANIA	All the year, with peaks October-November and May
SPAIN	
Coast of Blanes	From May to the end of August
Coast of Castellón	All the year round
Coast of Málaga	All the year round, uniformly
TURKEY	All the year, especially in winter months
U.S.S.R.	
Black Sea	All the year, especially in winter months
Azov Sea	From spring to autumn
YUGOSLAVIA	From April to October, especially in summer months

is rare, although in the Adriatic it is very good at temperatures higher than those.

5.4 Fishing operations and results

5.4.1 Effort and intensity

There is not sufficient data on the effort and intensity in all Mediterranean areas, but it is known that most of the effort and intensity (constituting about 30 to 40 percent of total fish catches in this area) are in the Black Sea.

5.4.3 Catches

See Table XV and Fig. 11.

In the central eastern Adriatic, the coincidence of the catch of anchovy and Spanish mackerel has been recorded during the period 1931-1940 by Mužinić (1958) (see Fig. 12).

Table Xv
Annual catches

Country	Quantities (thousand metric tons)						Observations
	1955	1956	1957	1958	1959	1960	
France (Incl. Algeria)	7.3	6.9	6.2	5.6	6.4	4.6	Mixed with Atlantic anchovy
Greece	1.0	5.7	6.0	9.5	7.8	-	
Italy	-	-	-	23.9	20.8	20.5	
Spain (Inc. Ceuta and Melilla)	75.8	78.5	69.6	91.3	90.4	100.5	Mixed with Atlantic anchovy
Turkey	7.6	7.8	13.1	9.5	48.9	-	
U.S.S.R.	7.5	9.4	18.0	25.9	42.6	33.2	
Yugoslavia	1.5	1.9	1.6	1.2	1.4	1.0	

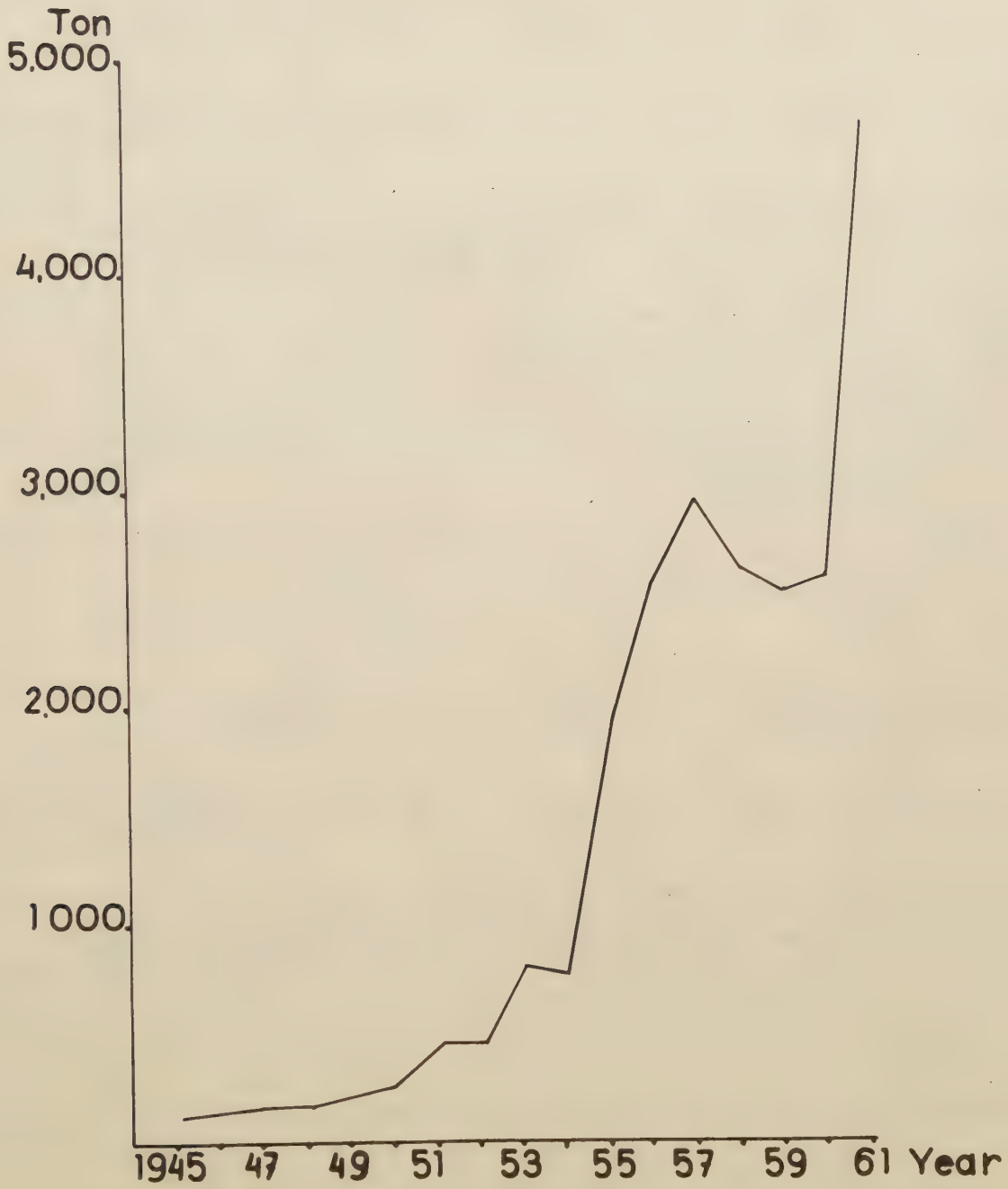

Figure 11. Engraulis encrasicolus landed on the market of Chioggia (Upper Adriatic) (Mozzi, 1964)

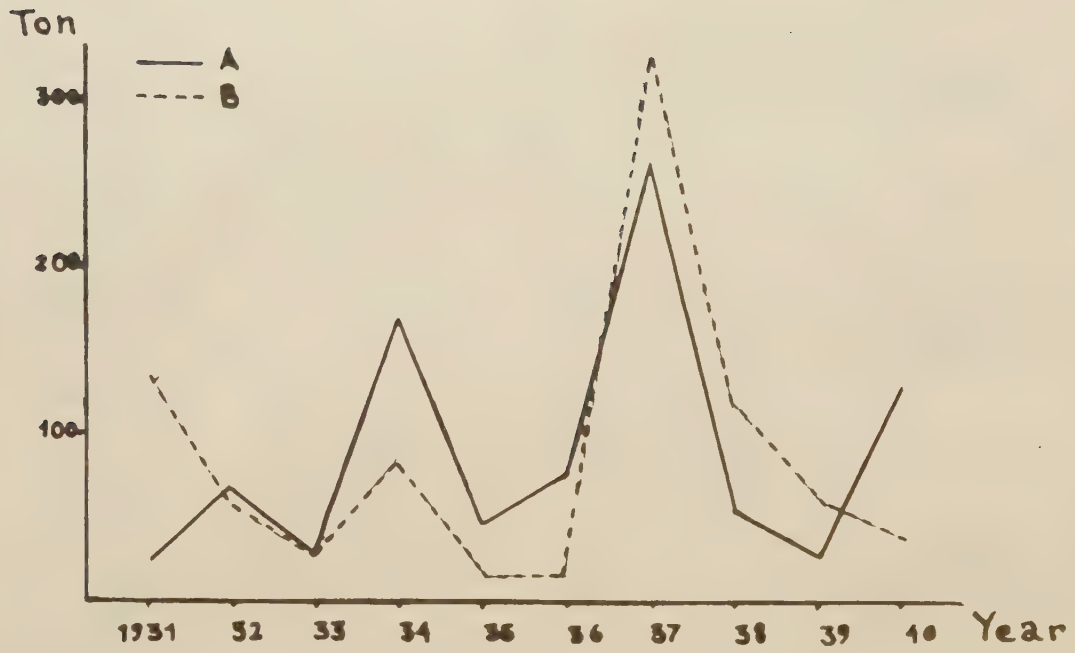

Figure 12. The coincidence of the catch of anchovy (A) and Spanish mackerel (B) in the Central Eastern Adriatic (Mužinić, 1958)

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SYNOPSES OF FISHERIES BIOLOGICAL DATA

This is one of a series of documents issued by FAO and CSIRO concerning species and stocks of aquatic organisms of present or potential economic interest. The primary purpose of the series is to make existing information readily available to fishery scientists according to a standard pattern, and by so doing also to draw attention to gaps in knowledge. It is hoped that synopses in the series will be useful to other scientists initiating investigations of the species concerned or of related ones, as a means of exchange of knowledge among those already working on the species, and as the basis for comparative study of fisheries resources. They will be brought up to date from time to time as further information becomes available. It is, therefore, recommended that they be filed in loose-leaf folders; pagination begins anew with each chapter, so that partial revisions may be made.

The relevant series of documents are:

FAO	**Fisheries Synopsis No.** (replacing, as from 1.1.63	FIb/S
FAO	Fisheries Biology Synopsis No. and	FB/S)
CSIRO	**Fisheries Synopsis No.**	DFO/S

Synopses in these series present data compiled according to a standard outline described in FB/S1 (1962). Steps are being taken to form an advisory association comprising representatives of the participating organizations, authors of synopses and other collaborators.

FAO and CSIRO are working to secure the co-operation of other organizations and of individual scientists in drafting synopses on species about which they have special knowledge, and welcome offers of help in this task. Additions and corrections to synopses already issued will also be most welcome. Comments including suggestions for the expansion of the outline and requests for information should be addressed to the co-ordinator of this work and editor of the FAO series:

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The following synopses in this series have been issued since January 1964:

FIb/S24 (Rev. 1)	Synopsis of biological data on European Grayling *Thymallus thymallus* (Linnaeus) 1758	March 1964
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FIb/S26 (Rev. 1)	Synopsis of biological data on anchovy *Engraulis encrasicolus* (Linnaeus) 1758 (Mediterranean and adjacent seas)	November 1965

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